CHAPTER 12

PRINTERS

INTRODUCTION

Printers have been around since the early days of the computer. The first printers were actually typewriters and teletypewriters that were adapted to print binary data. These printers were often slow and noisy. Today, there are printers that print entire pages of text and/or graphics at astonishing speeds.

After completing this chapter, you should be able to:

- **Define the terms *character set, font, point,* and *orientation* as they pertain to printers**
- **Describe impact and nonimpact printers**
- **Describe the operation of line printers**
- **Describe the operation of dot matrix printers**
- **Describe the operation of daisy wheel printers**
- **Describe the operation of laser printers**
- **Describe the operation of electrothermal printers**

Printers are classified as impact or nonimpact printers, depending on the method used to print the characters on the paper. Impact printers use hammers or pins to strike an inked ribbon and print the character on paper. Nonimpact printers print characters using electricity, a chemical process, or a combination of both.

Impact and nonimpact printers can be sub-divided into three types:

- Character printers
- Line printers
- Page printers

Character printers output data to the printed form one character at a time, line printers print one line of information at a time, and page printers print one whole page of data at a time. Character, line, and page printers can be either impact or nonimpact printers.

TOPIC 1—FUNDAMENTALS OF PRINTING

The purpose of any printer is to transform information from computers into characters or pictures on paper so that humans can read the information. In other words, printers provide a hard-copy output that we can understand. This topic will introduce you to the fundamentals of printing: character sets, line characteristics, and orientation.

CHARACTER SETS

A character set is a predefine table of characters that a printer will print. Early printer and computer manufacturers often defined their own codes to represent each character to be printed. Since the computers and printers from different manufacturers didn't talk the same language, users trying to build customized systems often ran into major communications problems. These problems led to the development of the American National Standard Code for Information Interchange (ASCII, pronounced *as-key).*

The ASCII Character Set

ASCII codes are 8-bits long, and standardize the codes for alphanumeric characters, some special characters, and some control codes. Codes 0 through 31 and 127 are control codes. Codes 32 through 126 are printable character codes. Table 12-1 lists the printable ASCII codes with their decimal codes.

Table 12-1.—Printable ASCII Codes

DECIMAL CODE	ASCII CHARACTER	DECIMAL CODE	ASCII CHARACTER	DECIMAL CODE	ASCII CHARACTER	DECIMAL CODE	ASCII CHARACTER
32	SPACE	56	8	80	P	104	h
33	!	57	9	81	Q	105	i
34	"	58	:	82	R	106	j
35	#	59	;	83	S	107	k
36	$	60	<	84	T	108	l
37	%	61	=	85	U	109	m
38	&	62	>	86	V	110	n
39	'	63	?	87	W	111	o
40	(	64	@	88	X	112	p
41	)	65	A	89	Y	113	q
42	*	66	B	90	Z	114	r
43	+	67	C	91	[	115	s
44	,	68	D	92	\	116	t
45	–	69	E	93	]	117	u
46	.	70	F	94	^	118	v
47	/	71	G	95	_	119	w
48	0	72	H	96	`	120	x
49	1	73	I	97	a	121	y
50	2	74	J	98	b	122	z
51	3	75	K	99	c	123	{
52	4	76	L	100	d	124	|
53	5	77	M	101	e	125	}
54	6	78	N	102	f	126	~
55	7	79	O	103	g		

Referring to table 12-1, if you want to print the word **Navy,** you would send the decimal codes 78, 97, 118, and 121 to the printer.

An 8-bit code can represent decimal values from 0 through 255 making it possible to represent 256 different codes with one character set. ASCII only defines the first 128 codes. The other 128 codes are used by software developers and printer manufacturers for additional characters. The additional characters are called the **alternate character set.**

Alternate Character Sets

With the development of printers capable of printing graphics and nonstandard characters, the second half of the ASCII character set (128 through 255) became available to define additional special characters and features. Because software programmers found that having only one character set severely limited the capabilities of graphic capable printers, additional character sets were developed. Today, it is not unusual to find programs with eight or more complete character sets. These additional character sets may contain math symbols, foreign alphabets such as Greek, Russian, or Japanese, and other special symbols.

To print the characters in an additional character set, you must have a graphics-capable printer and the program must specify the character set as well as the character code. Therefore, the characters printed are a combination of hardware and software capability. To make all this work together, software programmers must write a routine called a printer driver that performs several functions. A **printer driver** is written for each printer the software will support. The driver tells the software what the capabilities of the printer being used are and tells the printer how to print each character in the character set or sets.

CONTROL CODES

To make a printer print, the computer must have a method to control the printer. Printer control is accomplished with control codes. The original ASCII code contains 32 control codes. However, additional codes are needed to control the special features in modern printers. Most printers use a combination of the ASCII control codes and **escape** codes to enable and disable printer functions.

Table 12-2.—Selected ASCII Control Codes

DECIMAL CODE	ASCII ABBREVIATION	FUNCTION
02	STX	Start-of-text character.
09	HT	Horizontal tab.
10	LF	Line feed—Advances paper one line.
12	FF	Form feed—Ejects paper to the top of next form.
13	CR	Carriage return—Returns carriage to left margin.
27	ESCAPE	On many printers, the escape code indicates the start or end of a printer command.

ASCII Control Codes

Table 12-2 shows examples of the ASCII control codes. Some of them you will recognize, such as **carriage return** and **line feed.**

When printing, if the printer reaches the end of a line, the software must send a carriage return and a line-feed code. Without the line-feed code, the printer would overstrike the data just printed. The start-of-text tells the printer that all the codes following are data codes to be printed. Some printers have a selectable option that will automatically generate a line feed for every carriage return.

Escape Control Codes

The technology of printers has grown so that the original ASCII control codes can no longer support all the capabilities of most modern printers. Escape control codes are used to enhance printer operations beyond the limitations of the ASCII codes. Escape refers to the ASCII code 027, or the code generated by the **ESCAPE key** of the keyboard. Escape control codes can be used to change the style of print, the size of the print, whether the print is bold, and various other features of the printer. Escape codes are not standard and are defined by the printer manufacturer.

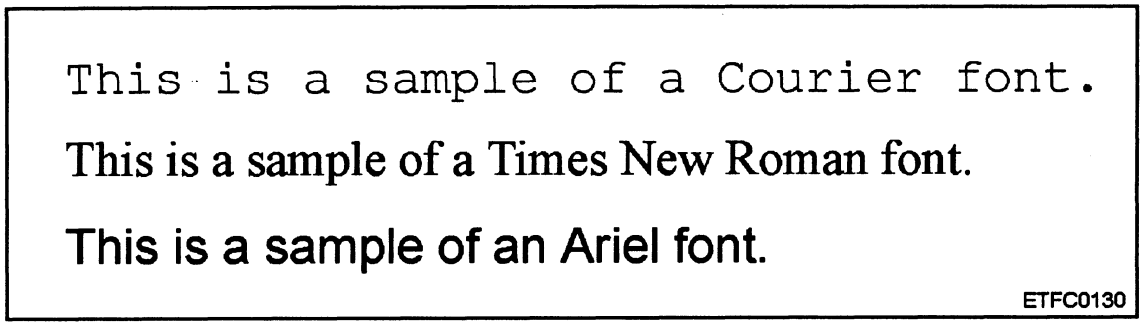

Figure 12-1.—Samples of different fonts.

An escape control code is the ASCII escape code (27) followed by one or more additional characters. For example, a dot matrix printer may use **ESCAPE C** to start underlining text and **ESCAPE D** to stop underlining. Another example of an escape control code could be **ESCAPE (s1S)** to select *italics* as the style of print. The decimal representation of this string is 027, 040, 115, 049, 083.

Controlling the medium- and high-speed printers used with mainframe computers is accomplished with external function messages from the computer. These printers use ASCII codes to determine the characters to be printed.

LINE CHARACTERISTICS

Line characteristics refer to the method of character spacing, the size of the characters, the number of characters printed per line, and the number of lines per inch.

Character Spacing

Depending on the type of printer being used, character spacing can be freed or proportional. Fixed spacing means each character, upper and lower case, requires the same amount of space on the line. With proportional spacing, narrower letters use less space than wider letters. For example, a lowercase *i* requires less space than an upper case *W*. With proportional spacing, the number of characters per inch is an approximation. With fixed spacing, the number is always the same.

Character Size

Character size can be affected by many factors, depending on the type of printer being used. Drum printer character size is freed and difficult to change. Most dot matrix and laser printers can print a wide variety of character sizes and fonts. Font refers to the style of the typeface, such as Courier, Times New Roman, or Ariel, combined with the size of print and the stroke weight (for example, **bold).** Figure 12-1 illustrates several common fonts.

Character size is also selectable on many printers. Character size is expressed in terms of pitch (characters per inch) or point size. Point refers to a printer's measure of print height. One point is equal to 1/72 inch. All the fonts illustrated in figure 12-1 are 12-point fonts. Note how the typeface affects the character spacing. Figure 12-2 illustrates the same typeface printed in several different point sizes.

ORIENTATION

Orientation refers to how the characters are printed on the page. There are two modes of orientation: **portrait** and **landscape.** When portrait mode is selected, the data is printed across the width of the page.

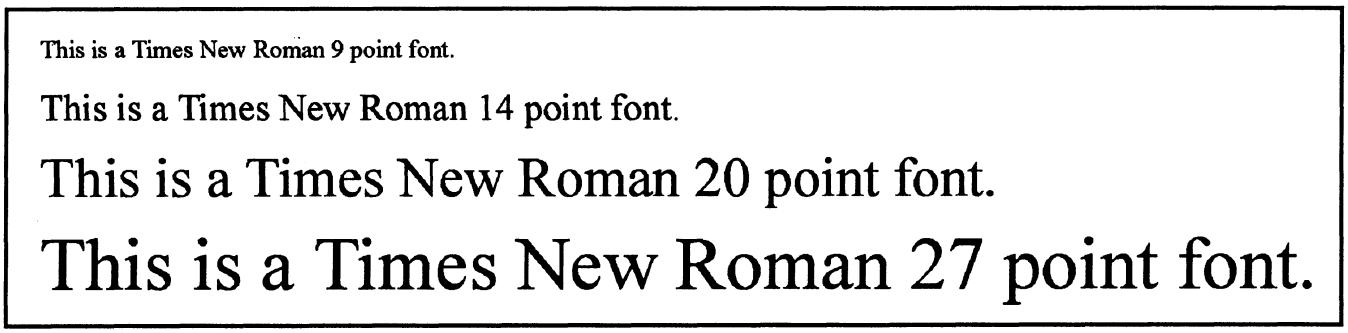

Figure 12-2.—Samples of different point sizes of the same typeface.

The text that you are reading now is printed in portrait mode. In landscape mode, the page is rotated 90 degrees and the data is printed across the length of the page. Using standard paper, portrait mode is aligned 8.5 inches wide × 11 inches long; in landscape mode the paper is aligned 11 inches wide × 8.5 inches long.

Orientation is selectable on some dot matrix printers, ink jet printers, and all laser printers.

TOPIC 2—BASIC PRINTER CHARACTERISTICS

All printers have the same function, that is to print data on paper. The method they use to put the information on paper varies with the type of printer. This section covers areas of the printer that are common to most printers: interface, control, paper feed, and power supply.

INTERFACE SECTION

All printers need **to communicate with the host** computer. Communications is handled in the **interface section.** Printers connected to mainframe computers generally have a communications protocol that is designed for the computer, such as NTDS fast or NTDS slow interface. Smaller printers used with personal computers will have either serial or parallel interfaces. The most widely accepted serial interface is "Recommended Standard-232" or simply **RS-232.** The most widely used parallel interface is the **Centronics standard parallel interface.**

RS-232 Serial Interface

RS-232 was developed by the Electronics Industry Association (EIA) **to be a universal serial interface** standard for any serial device such as **a** modem, printer, or keyboard.

For **a** printer **to** properly receive serial data, the parallel bytes **that the** computer works with must be converted into a serial data string. Once the data string is received by the printer, it must be reconverted to parallel data for the printer to use. These conversions are accomplished by a special circuit called a **universal asynchronous receiver/transmitter** (UART). The UART can perform both parallel **to serial and serial to** parallel conversions. UARTs do not need extra control lines to control the flow of data, so the UART never knows when anew character is arriving. To send a data word, the UART must attach from two to four extra bits. First, the UART inserts a binary ZERO to represent a start bit. The next seven or eight bits represent the actual data code. Although some printers still work with seven data bits, eight bits is the standard found on most printers today. After the data code is sent, the parity of the data is checked and a parity bit maybe added. Whether a printer uses even or odd parity is determined by the manufacturer and is set up when the printer is connected to a computer. To end the data word, the UART adds one or two stop bits. Configuring the UART for a printer is accomplished by setting a number of dip switches of the circuit board.

The RS-232 interface cable is connected to the computer and printer by a DB-25 sub-miniature connector. The DB-25 connector is a 25-pin D-type connector. Although the connector has 25-pins, serial communications with software **handshaking** needs as few as three of the pins connected.

Handshaking signals are signals that control the printer. Software handshaking uses the ASCII codes such as **XON/XOFF** and **ETX/ACK.** Hardware handshaking uses an additional line to indicate **data terminal ready** (DTR) to the computer's **data set ready** (DSR) pin. When hardware handshaking is used, the printer cannot send data to the computer.

Centronics Parallel Interface

The Centronics parallel interface uses a 36-pin Centronics connector at the printer end of the cable and a DB-25 subminiature connector at the computer. The parallel interface is an eight-bit, two-way interface between the computer and the printer. When the computer sends data to the computer, it places the data on the data lines and sets a strobe signal. The strobe signal indicates to the printer that the data is ready for transfer. When the printer samples the data, it will set the acknowledge line to tell the computer it has sampled the data.

CONTROL SECTION

The control section of a printer directs all printer operations. This section receives and decodes computer data from the interface section. If the data contains characters to be printed, the control section determines what character it is and when to activate the print mechanism. The print mechanism can be a print hammer, a series of print wires, a laser beam, or some other mechanism. The control section receives signals from various parts of the printer as to the presence of paper, carriage position, and print head temperature.

CONTROL PANEL

The control panel allows the operator to set the printer's operating parameters such as font, characters per inch, and print quality. The operator may also be able to run a self-test to check various fonts and print quality. The control panel can also be used to advance the paper to the top of the form or advance the paper one line. There is usually a switch to control whether the printer is online or offline. When operators perform any actions with the control panel, they should be sure the printer is offline to prevent any stray interrupts being sent to the host computer.

PAPER-FEED ASSEMBLIES

The two most common methods of feeding paper through a printer are the **tractor feed** and **friction feed.** Some printers may have both friction feed for single-sheet paper and tractor feed for continuous paper.

Tractor Feed

Tractor feed is probably the most common of all paper-feed methods. It is easily recognized by the type of paper used and the tractors that actually move the paper. Figure 12-3 shows the basic components of a tractor paper-feed assembly. Tractor feed uses continuous paper with perforated holes on each side. The paper is threaded through the printer's platen to the tractor's sprockets. The perforated holes on each side of the paper are lined up with the sprockets and the paper is held in place when the sprocket covers are closed.

The paper is advanced by a paper-feed motor. This is generally a stepper-type motor, where each step advances the paper one line. The paper-feed motor turns the platen, which is connected to the tractors by a drive belt or a set of gears.

Friction Feed

Printers using a friction-feed paper advance are capable of handling both continuous flat folded and single sheets of paper. With friction feed, the paper is held firmly against the platen by a pressure roller. To advance the paper, the paper motor turns the platen, which causes the paper to advance.

Another type of friction feed, the sheet feeder, is common in laser printers and uses a series of rollers to transport the paper through the printer. Figure 12-4 illustrates the basic operation of this type of paper feed. The pick up roller picks the top sheet of paper in the tray. A separation pad ensures that only one sheet of

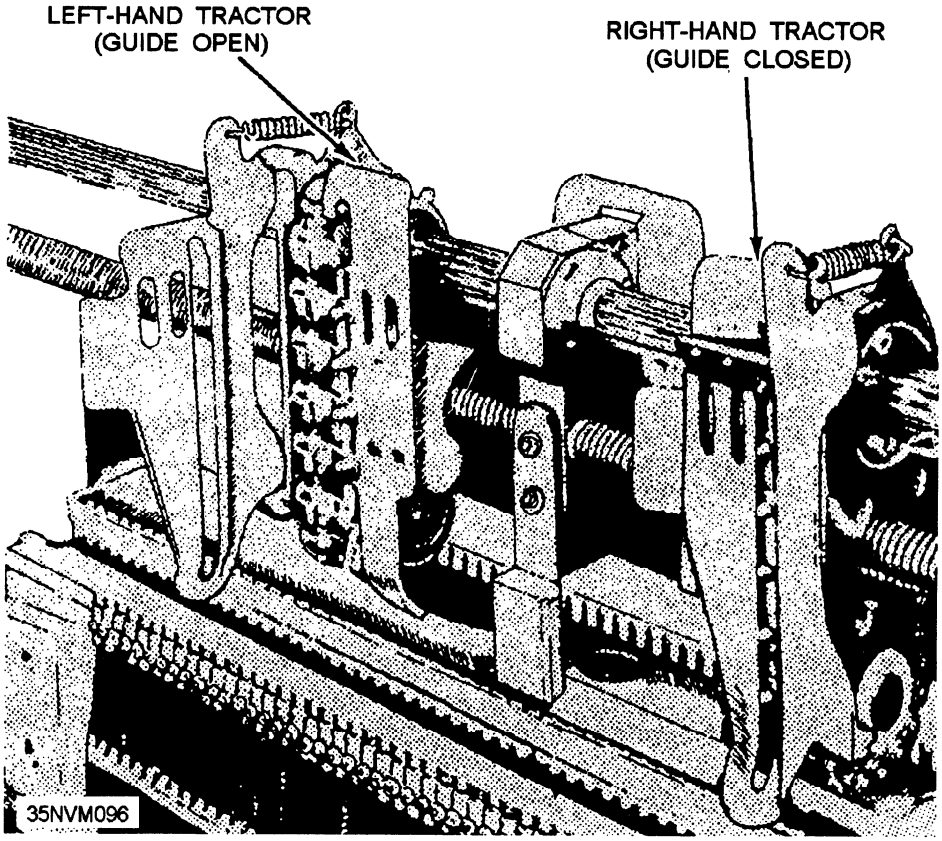

Figure 12-3.—A tractor-feed assembly.

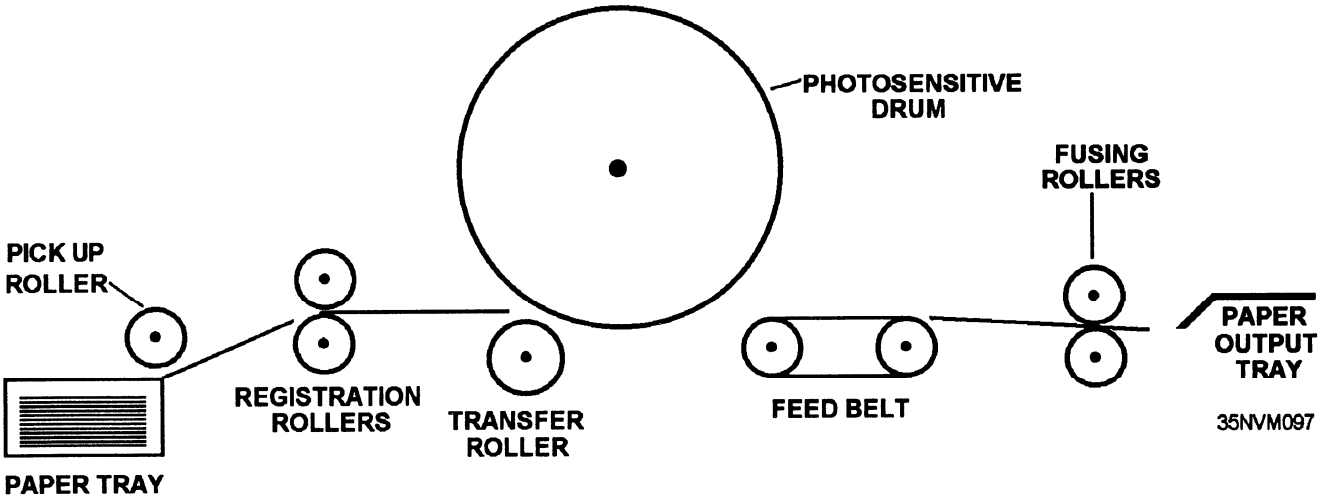

Figure 12-4.—A laser printer paper feed.

paper is picked up. The registration rollers align the paper so that it is straight. The registration rollers feed the paper to the transfer roller. The transfer roller presses the paper against the drum **to** transfer the toner from the drum to the paper. The paper then passes through the fusing rollers. The fusing rollers are heated rollers that melt the toner to the paper. The paper is then fed to the paper output tray.

POWER SUPPLY

All printers have a power supply to provide the proper operating voltages for the printer. The output voltages and current of the power supply depend on the type of printer.

TOPIC 3—IMPACT PRINTERS

Impact printers form characters on the paper by striking a device against an inked ribbon and into the paper, causing a character to be imprinted on a sheet of paper. Common impact printers include the following:

- Drum printers
- Band printers
- Dot matrix printers
- Daisy wheel printers

Impact printers can be line printers or character printers.

LINE PRINTERS

Line printers receive data to be printed from the computer and store the data until a complete line is ready to be printed. The line printer will print several characters at a time. The types of impact line printers commonly used in the Navy are the drum, chain, and band printers.

Drum Printers

In a drum printer, the character set is inscribed as raised fonts on a hollow metal drum. These raised characters are formed into lines or bands on the drum. Figure 12-5 shows atypical print drum. All the A's are on one line, all the B's are on the next line, and so forth, until all the characters in the set form a line each. The character set is repeated for each column that the printer

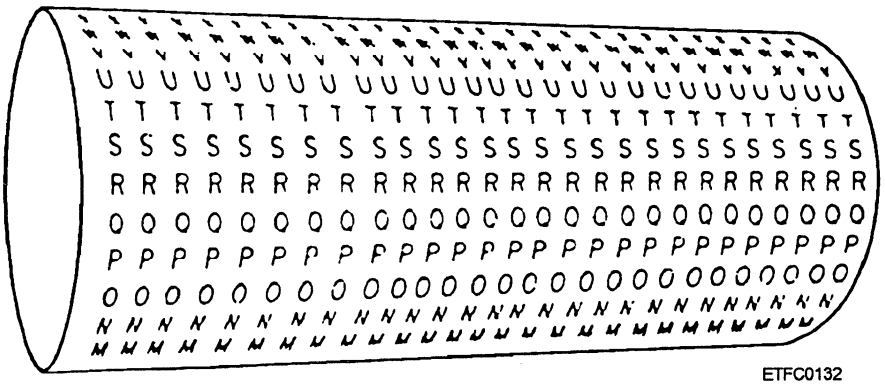

Figure 12-5.—A print drum showing character lines.

is capable of printing. If the printer is an 80-column printer, the drum has 80 characters on each line.

The character drum is rotated at a high speed. As the desired character faces the paper, a **print hammer** for that column is activated or fired, forcing the paper and inked ribbon against the drum. The character on the drum is imprinted on the paper as shown in figure 12-6.

Normally, the **hammer bank** contains one hammer for each character column of a line. If the printer has a capacity to print 132 columns, then the hammer bank will consist of 132 hammers. As a line is printed, each hammer is fired as the character to be printed in its column faces the paper.

A drum printer prints one line of data for each rotation of the drum. Drum printers can print from 300 to 1,200 lines per minute, depending of the rotational speed of the drum and how fast the printer can setup to print the next line.

Chain and Band Printers

Chain printers use a **print chain** as a source of raised characters. The links of the chain are engraved character-printing slugs. The chain is made up of several sections; each section contains one complete character set.

The print chain is rotated at a high rate of speed past the print positions (columns). As the desired character faces the paper, the print hammer for that column is fired, printing the character on the paper.

Band printers work on the same principle as chain printers except that a scalloped, steel **print band** is used instead of a print chain. Figure 12-7 illustrates part of the band printer's print mechanism.

To change the font (typeface) on a chain or band printer, you change the print chain or band. Character sets of the chain and band printers vary, but are typically 48 to 64 characters. Since hammers are of a freed size,

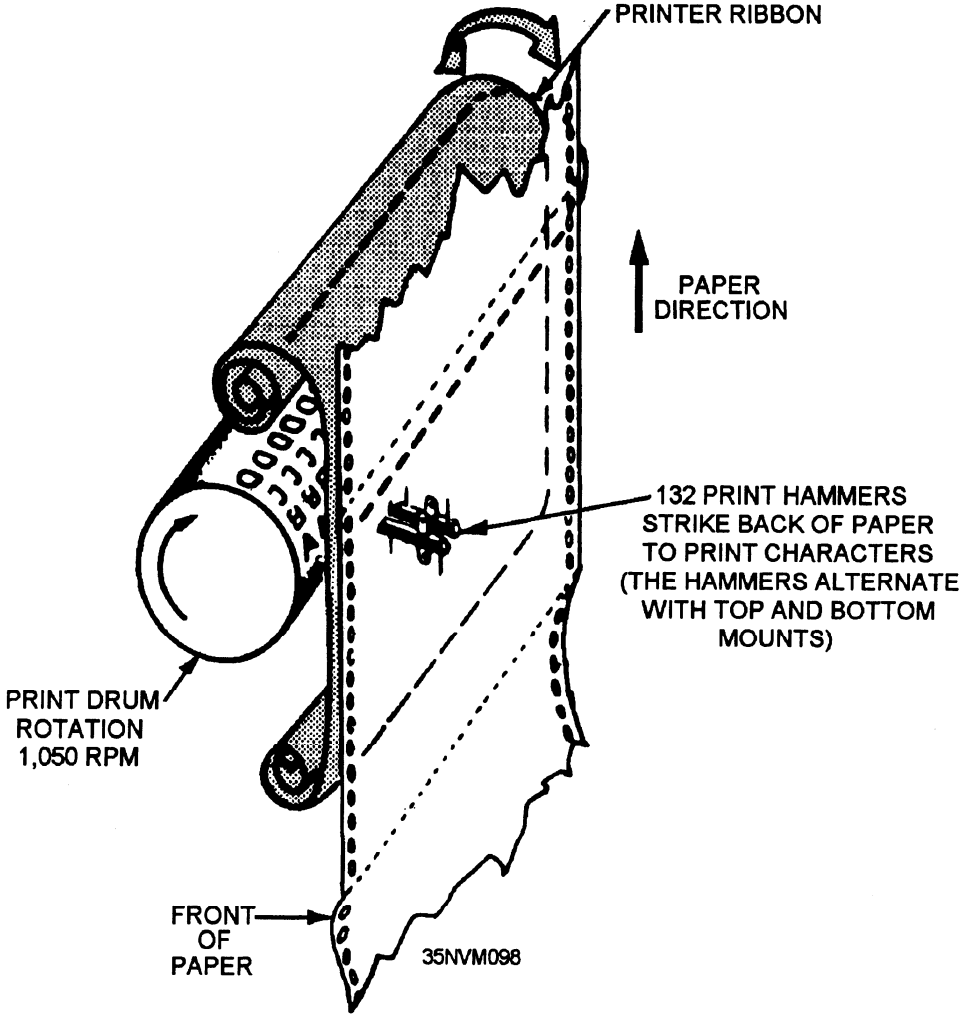

Figure 12-6.—Drum, ribbon, and paper relationship during printer operations.

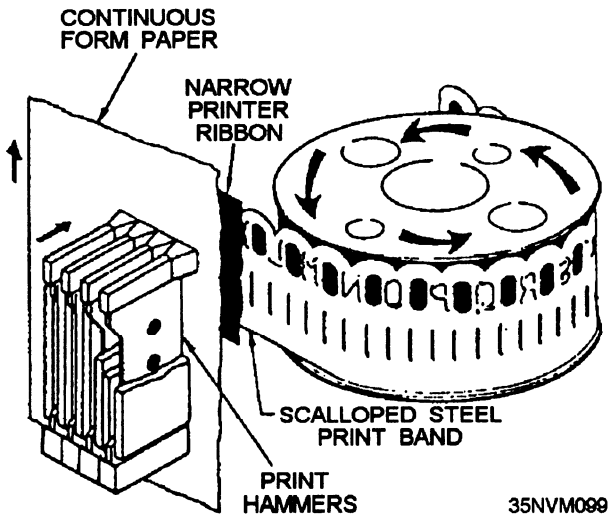

Figure 12-7.—Band, paper, ribbon, and hammer relationship in a typical band printer.

changing the size of the fonts is not possible because each column printed must have its own print hammer. Band and chain printer characters are generally printed at 10 characters per inch (cpi), although a few printers have been manufactured to print 12 cpi.

Chain and band printers are medium- and high-speed printers. They print over 300 lines per minute.

CHARACTER PRINTERS

Character printers print one character at a time. Most character printers are impact-type printers. The notable exception to this is the ink jet printer, which sprays ink on the paper to print characters. The common impact character printers are the dot matrix and the daisy wheel printers.

Dot Matrix Printers

A dot matrix printer forms characters by printing a series of small dots. The heart of the dot matrix printer is the print head. The print head contains a series of print wires, small pins that strike the page to create characters and graphics. The quality of print from a dot matrix printer is directly related to the number of print wires in the print head. The most common print heads use 9 or 24 print wires. Figure 12-8 illustrates the nine-pin print head.

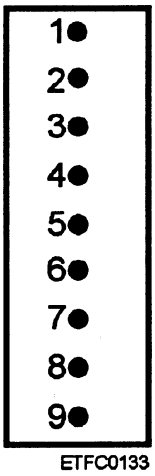

Figure 12-8.—A single column, nine-pin print head.

The print wires in the print head are independently driven by individual solenoids. A pulse applied to the selected solenoid forces the print wire into the ribbon and the paper. The print wire is returned to its normal position by a spring that holds it in the print head. The firing of the print wires can occur over 300 times per second.

The print wire solenoid driver pulse generates heat. The print head is usually mounted on a heat sink because of the speed at which the print head operates. The heat sink uses ambient air to disperse heat that, if left unchecked, would damage the print wires.

The quality of print generated by dot matrix printers has improved greatly over time. Older printers contained only seven print wires and the dots were clearly visible. Because of this, dot matrix printers were often used for only draft work and the final document was reprinted on a daisy wheel-type printer or manually typed. Today, many dot matrix printers have a print mode refereed to as **near letter quality** (NLQ). Letter quality refers to the quality of print typically generated by a typewriter. Near letter quality print has become acceptable for all but the most formal of communications.

A dot matrix printer using the nine-pin print head shown in figure 12-8, will initially print a character in the **draft** mode. The paper is then advanced one-half dot space and the character is printed again. This will fill in the space between the dots and the characters will appear smoother.

A 24-pin print head prints near letter quality faster because it has two vertical columns of print wires. The print wires in column two are slightly offset from

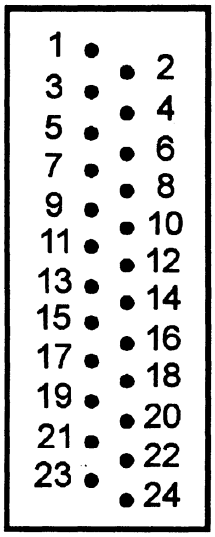

Figure 12-9.—A typical print wire arrangement in a 24-pin dot matrix print head.

column one as shown in figure 12-9. Near letter quality can be printed with just one pass of the print head. The print wires are smaller in diameter than the ones on a nine-pin print head, resulting in even smoother characters.

The dot matrix print head is mounted to a low friction slide that is mounted to one or two carriage rails. The carriage rails are usually finely polished steel to further reduce friction. The print head is moved across the length of the platen by a wire, belt, or chain that is connected to the print head mount and to the carriage motor. As the motor turns, it pulls the mount either right or left. On the rails are right and left limit switches that prevent the carriage motor from pulling the print head too far in either direction. The limit switches maybe mechanical switches or optical sensors. Figure 12-10 shows a basic carriage assembly.

Daisy Wheel Printers

The daisy wheel printer uses a single print hammer and produces letter quality print. A daisy wheel is a small plastic disk with a number of petal-like projections. A character die is located on the end of each projection as shown in figure 12-11.

The daisy wheel is rotated by the print head mechanism until the desired character is in the proper position to be struck by the print hammer. The hammer drives the die into the inked ribbon, which prints the character on the paper as shown in figure 12-12. The print head is then moved one space, the wheel is rotated to the next character to be printed and the hammer is fired again. This process is repeated until the entire line has been printed. Many daisy wheel printers are capable of bidirectional printing.

The daisy wheel print head is mounted to a carriage assembly that is very similar to the assembly used with dot matrix printers.

Daisy wheel printers are slow and limited in the characters printed to those on the wheel. Despite these limitations, they are still used for their ability to print letter quality documents and make carbon copies.

TOPIC 4—NONIMPACT PRINTERS

Nonimpact printers form characters using methods other than striking an inked ribbon and the paper. Types of nonimpact printers include the following:

- Laser
- Electrothermal
- Inkjet
- Electrosensitive
- Electrostatic

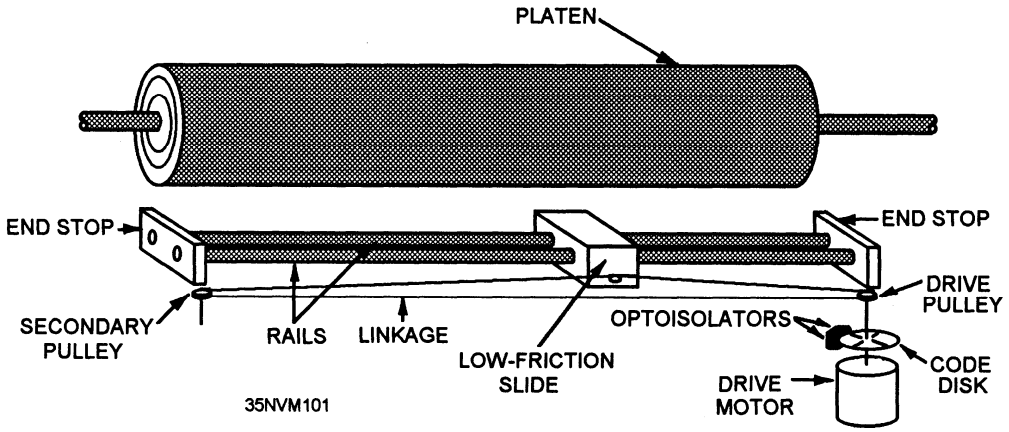

Figure 12-10.—A basic printer carriage.

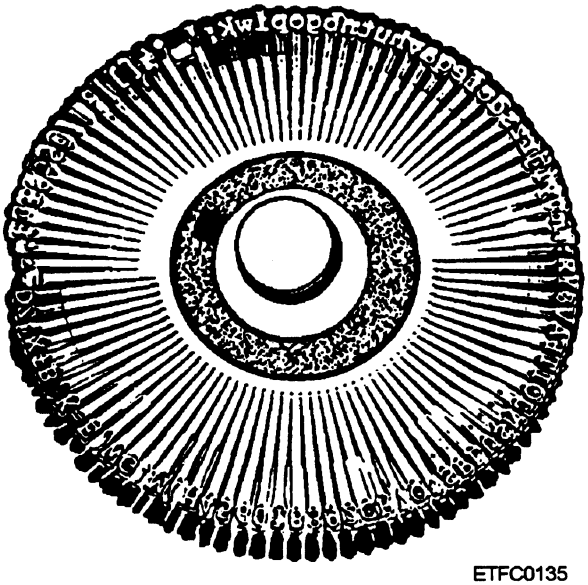

Figure 12-11.—A daisy wheel.

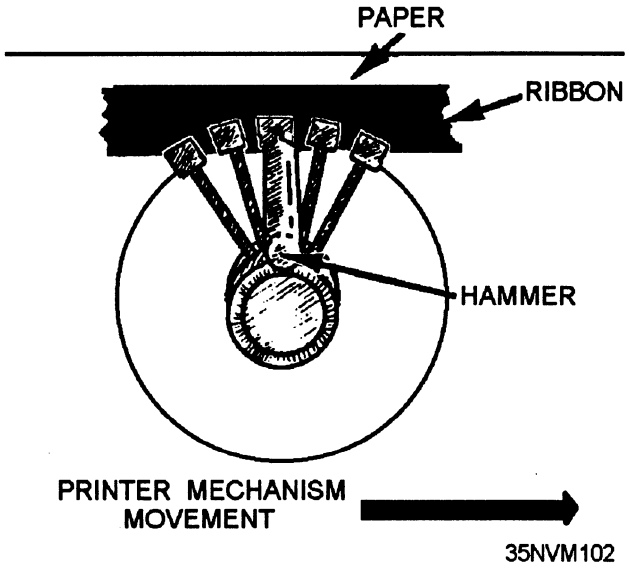

Figure 12-12.—A daisy wheel print mechanism.

LASER PRINTERS

Laser printers are a type of electrostatic printer that produce a very high resolution print on plain paper. Laser printers are classified as page printers; that is, they print a whole page at a time. Laser printers can print from four to eight pages per minute with a resolution of 300 to 600 dots per inch (dpi).

The development of a laser engine by Canon U. S.A., Inc., is largely responsible for the laser printer's popularity and affordability. The Canon engine combines the print drum, toner, and other parts into a single, easily replaced disposable cartridge.

Laser Print Cycle

The laser printer's disposable cartridge is the heart of the printer's system. The cartridge contains the print drum, primary corona wire, a supply of toner, cleaning blade, erase lamp, and rollers. The laser printer's image formation process is illustrated in figure 12-13.

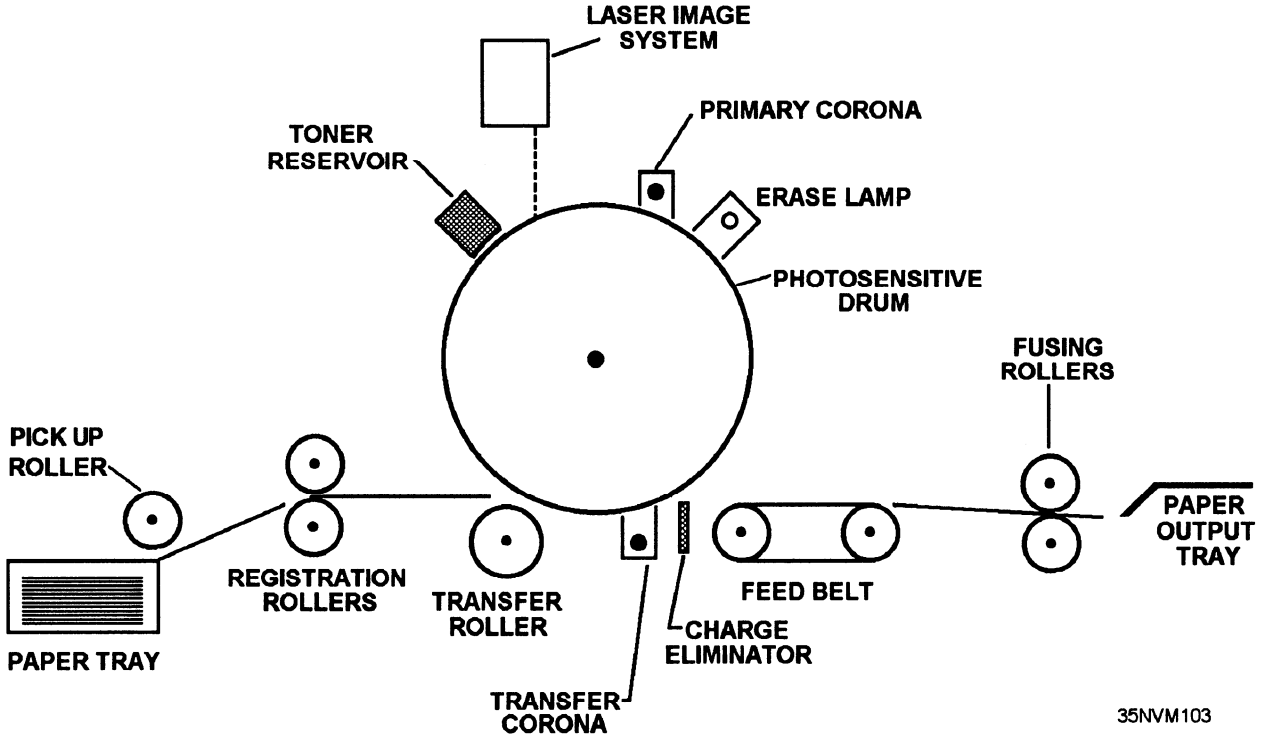

Figure 12-13.—A laser printer's image formation process.

The print drum is an aluminum cylinder coated with a photosensitive material. This material is highly conductive when exposed to light and has low conductance in darkness.

The laser source is from a small laser diode that generates a single wavelength light in bursts of a millionth of a second or less. The laser is focused on the drum and illuminates areas of the drum to form characters.

To start a print cycle, the drum is first cleaned, both physically and electronically. The cleaning blade wipes any residual toner from the drum. The erase lamps are turned on and neutralize any charge that maybe on the drum. A negative charge of approximately -600V is applied to the entire drum surface by the primary corona wire.

The laser beam is applied to the drum, causing the exposed areas of the drum to become positively charged. Figure 12-14 shows the basic laser imaging and scanning mechanisms. The laser beam is directed through a shutter to a rotating hexagonal mirror. As the mirror rotates, the area of the drum that the reflected beam strikes changes. This is the horizontal scan of the laser. To properly charge the drum, the laser shutter controls when the laser beam will actually strike the drum. When one horizontal scan is completed, the drum is advanced one dot space and the process is repeated. The characters are actually formed through a series of dots, much like a dot matrix printer.

As the drum is rotated, it passes by the toner reservoir. The toner consists of a very fine powder of metal, dyes, and plastic particles that are easily attracted by static electricity. As the exposed drum passes by the toner, the positively charged areas of the drum attract the toner while the other areas remain clean.

While all this is happening, the paper-feed section of the printer picks one piece of paper from the tray. The paper is lined up with the registration rollers and is ready to be printed on. The paper is passed over the transfer corona at the same time the charged area of the drum is over the paper path. The transfer corona charges the paper at a higher charge than the drum, pulling the toner from the drum to the paper. The paper never actually contacts the drum.

The image is now on the paper but it is not permanent. The paper is fed through the fusing rollers. The fusing rollers apply heat and pressure to the paper, causing the toner to melt and permanently bind to the

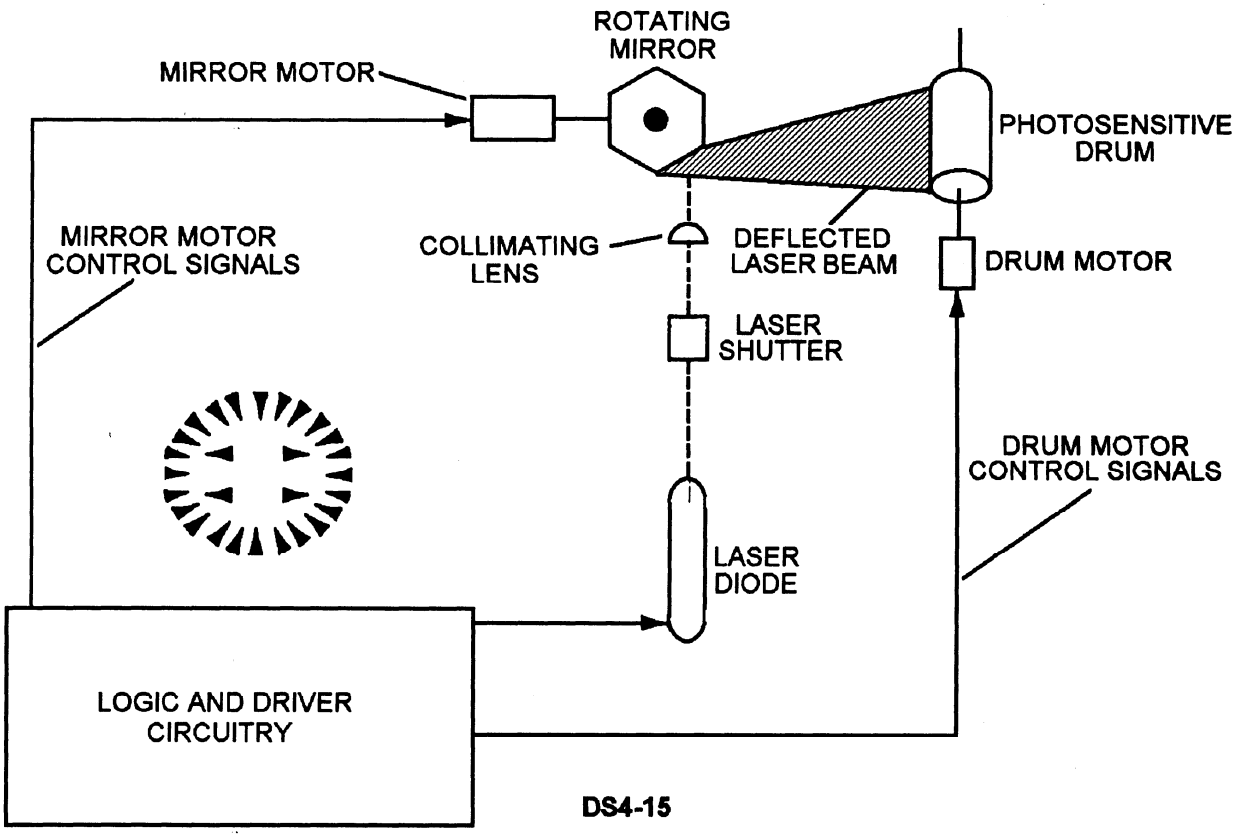

Figure 12-14.—A laser imaging system.

paper. Because the toner is melted to the paper, the print appears very smooth and loses the appearance of dots that are common with dot matrix printers.

The coating of the print drum is very soft. It can be easily scratched or chipped. Once the print drum has a scratch or chip in it, that area will show up as a blotch or line on all subsequent copies. Also, any of the rollers can get bent, scratched, or develop some type of irregularity and cause blotches. How do you determine what part failed? All of the rollers and the drum shown in figure 12-13 are different sizes. By measuring the spacing between the blotches on the paper, you can get a fairly good idea which area has the problem. Table 12-3 lists the approximate circumferences of the rollers inmost laser printers.

Laser Printer Page Languages

Currently there are two basic types of desktop laser printers, the Hewlett-Packard (HP) and the Adobe PostScript. Each has its own page description language. Just about all laser printers use or emulate one of these two languages.

HEWLETT-PACKARD SYSTEM. —When Hewlett-Packard developed its LaserJet series of printers, the fonts were largely developed from the existing dot matrix printer bit maps. A bitmap is a table that tells the printer when and where to place the dots. With the Hewlett-Packard system, a font definition is required for each font to be printed. Fonts can be resident in the printer's ROM, contained in a font cartridge which holds additional ROMs, or they can be soft fonts. Soft fonts are loaded into your computer's memory and transferred to the printer's RAM as they are needed.

Table 12-3.—Laser Printer Roller Circumferences

ROLLER	APPROXIMATE CIRCUMFERENCE
Upper registration roller	1.5 inches
Lower registration roller	1.75 inches
Transfer roller	2.0 inches
Lower fusing roller	2.56 inches
Upper fusing roller	3.16 inches
Photosensitive drum	3.75 inches

These printers offer very high resolution, a large variety of fonts, and the capability to print graphics. Depending on the model and manufacturer, the Hewlett-Packard and compatible laser printers, can print from four to eight pages of text per minute. Printing graphics can slow down the printer considerably.

POSTSCRIPT PRINTERS. —The PostScript family of printers, developed by Adobe Systems, uses an entirely different method for defining characters and graphics. Where the HP system needed a definition for each size font, the PostScript printer needs only one definition for each character in a character set. The definition of the font is a series of mathematical calculations instead of a fixed number of dots. From this definition, the PostScript printer uses mathematical scaling of the character to print it any size from 5 to 5,000 points.

By being described mathematically, the image can be manipulated in a number of ways. It can be rotated, shrunk, expanded, twisted, shadowed, or placed in a 3-dimensional prospective.

With the exception of how characters are defined, the basics of the PostScript printer are the same as the HP printer. They both use the same print mechanisms and interfaces.

ELECTROTHERMAL PRINTERS

Electrothermal printers use the heat of wires or pins to create images on a special heat sensitive paper. The paper changes color when exposed to heat, allowing the characters to appear.

INK JET PRINTERS

Ink jet printers form images and characters by spraying fine drops of ink on the paper. The most common type of inkjet printer is the drop-on -den and print head. Drop-on-demand printing means that ink is ejected out of the nozzles as needed.

Figure 12-15 shows atypical inkjet print head. The ink in the reservoir is fed to the nozzles. Characters are formed by spraying the ink in a series of dots, similar to the dot matrix printer. At the output of each nozzle is a small piezoelectric crystal that vibrates when an electric signal is applied to it. The piezoelectric crystals act as small pumps to squeeze the ink out. When a dot is needed, the control circuits send a driver signal to the crystal, which causes it to vibrate, squeezing the nozzle tube and forcing a drop of ink onto the paper.

Some ink jet printers use the bubble jet printing process. In this process, the piezoelectric crystals are replaced with small heaters. When a drop of ink is needed, a pulse applied to the heaters causes an air bubble to form in the ink nozzle. This rapidly expanding air bubble forces a drop of ink out of the nozzle and onto the paper. When the drive pulse is removed, the heaters cool almost instantly, creating a vacuum in the nozzle, which draws more ink from the reservoir.

Ink jet printers produce letter quality print. They are quiet, fast, and flexible. Some color printer manufacturers prefer the inkjet method for printing. To print color, three print heads are activated simultaneously. The amount of each primary color sprayed on the paper combines with the others to form all the colors of the spectrum.

SUMMARY—PRINTERS

This chapter has introduced you to the basic concepts of several different printers and printing techniques. The following information highlights important points you should have learned.

FUNDAMENTALS OF PRINTING —All printers exist to transform electronic digital data to a hard copy that we humans can comprehend. To ensure that printers and the host computer are speaking the same language, several printing standards have been developed.

CHARACTER SETS —A character set defines all the characters a printer can print. The original character set is known as the American Standard Code for Information Interchange, or ASCII codes. With the development of graphic capable printers, most word processing programs offer a wide range of character sets.

LINE CHARACTERISTICS —Line characteristics refers to how the characters are printed on a page. They include the typeface, spacing (fixed or proportional), and size.

ORIENTATION —Orientation is how the text is printed on a page: portrait or landscape. In portrait mode, text is printed across the width of the page; in landscape mode, text is printed across the length of the page.

BASIC PRINTER CHARACTERISTICS —All printers have several functions in common: interface section, control section, control panel, paper-feed assemblies, and power supply.

INTERFACE SECTION —The interface section controls the exchange of data between the host computer and the printer. There are several types of interfaces. Mainframe computers used with shipboard systems use standard NTDS interface protocols. Minicomputers and personal computers use either a

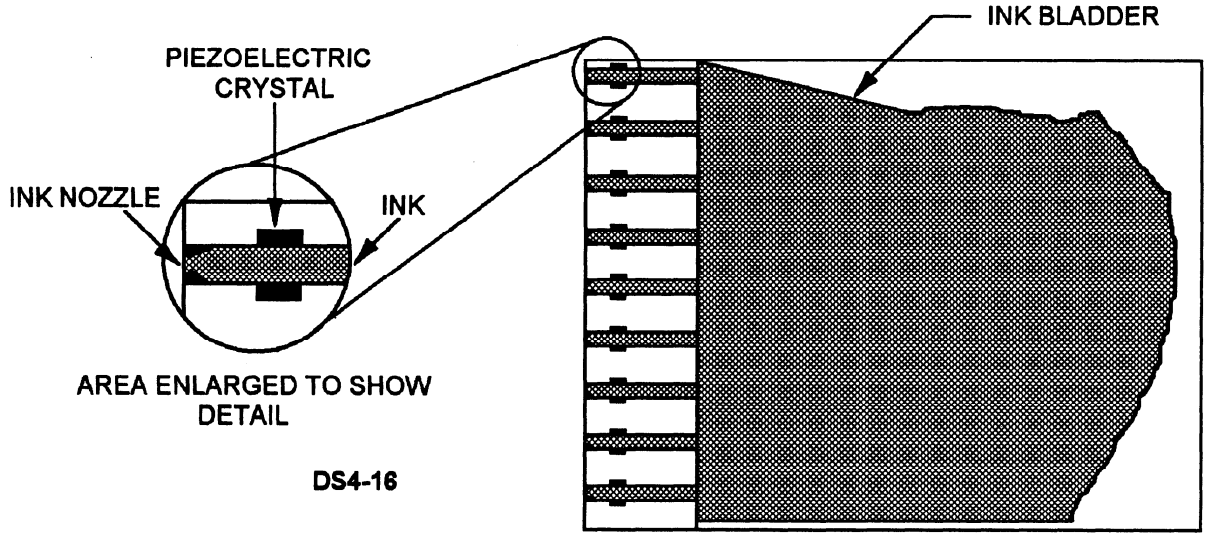

Figure 12-15.—An ink jet print head.

serial or parallel interface. Among these, the RS-232 in the most common serial interface and the Centronics parallel interface is the most common parallel interface.

CONTROL SECTION —The control section of a printer receives data from the interface section, decodes the data to determine whether it is a control word or data to be printed. The control section will then take the appropriate action.

CONTROL PANEL —The control panel lets the operator set some of the operating parameters of the printer and paper.

PAPER-FEED ASSEMBLIES —The paper-feed assemblies move the paper through the printer. Tractor feed and friiction f&dare two main types of paper feed.

POWER SUPPLY —The printer's power supply converts the ac line voltage to the required voltages for the printer to operate.

IMPACT PRINTERS —Impact printers form the characters by striking a device, such as a print hammer or print wire, against an inked ribbon and the paper.

LINE PRINTERS —Line printers are capable of printing at high speeds. They use rotating print drums, print chains, and print bands with raised character dyes to print characters. Character sets with these printers are limited to the characters on the drum, chain, or band.

CHARACTER PRINTERS —Character printers print one letter or character at a time. Two of the more common character printers are the dot matrix printer and the daisy wheel printer. The dot matrix forms characters using a series of print wires. The daisywheel printer uses a small plastic wheel with the character dyes on the spokes of the wheel.

NONIMPACT PRINTERS —Nonimpact printers use methods other than striking the paper through an inked ribbon.

LASER PRINTERS —Laser printers are a type of electrostatic printer that produce a very high resolution output. The laser printer uses a laser diode to form the image to be printed on a charged photosensitive drum.

ELECTROTHERMAL PRINTERS —Electrothermal printers form characters on a special heat sensitive paper. Small heaters are activated to form the characters, and the heat causes the paper to change color.

INK JET PRINTERS —Ink jet printers use a fine spray of ink to paint characters on paper.